

RHEOLOGY OF BARNYARD MILLET-BASED COMPOSITE DOUGH FOR CHAPATHI PREPARATION

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ABSTRACT

Barnyard millet (*Echinochloa frumentacea*) is the fastest growing of all millets and it is grown in India. The purpose of the study was the formulation of composite flour suitable for chapathi making using maximum possible proportion of barnyard millets. Hence, the barnyard millet flour incorporated to wheat flour at different levels, such as 15%, 30%, 45% and 60% for the formulated to composite flour. The composite flour increased the nutrient content such as protein (g), fiber (g) and minerals (g). Rheological properties of composite flour indicated that the water absorption was decreased gradually from 51.8% to 44.6% than control (54.2%). The dough development time (min), stability time (min), tolerance index (FU), time to breakdown of dough (min) and farinograph quality number (FU) of composite flour decreased, as 15% of incorporation of barnyard millet flour then increased as 30%, 45% and 60% of incorporation of it. Among the overall acceptability of sensory scores indicated that 15% and 30% of barnyard millet flour was highly acceptable as compared to 45% and 60% of incorporated barnyard millet flour. So, barnyard millet could be successfully value added, which increased the nutrient content without ignoring the palatability and various innovative products may be developed to suit the consumer needs and also to achieve nutrition.

KEYWORDS: Millet Flour, Refined Wheat Flour, Composite Flour & Rheological Properties of Dough

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INTRODUCTION

Millets are the first cereal grain used for domestic purposes. Millets are used as traditional healthy foods, which are prepared mostly in India. Further millets are rich in energy, protein (especially sulfur-containing amino acids), vitamins and minerals like calcium, iron and phosphorus. For these superior properties of minor millets, namely, called as “Nutritious Millets” (Mohan, 2012). Barnyard millet (*Echinochloa frumentacea*) is one of the fastest growing among all the millets, which was substituted for rice in India, Japan and China. In India, barnyard millet has several names, such as sawa, shama, samu, shamula, Japanese barnyard millet, ooda, oodalu, kudiraivali, sanwa, etc., (Lohani *et al.*, 2008). The crop is grown mainly in Orissa, Maharashtra, Madhya Pradesh, Tamil Nadu, Bihar, Punjab, Gujarat and Uttarakhand (Lohani *et al.*, 2012). Barnyard millet is superior to wheat and rice due to being three times rich in minerals like calcium, four times rich in fat (Gopalan *et al.*, 1997). It is rich in linoleic acid, palmitic and oleic acid. It has also had a highly digestible protein and dietary fiber (Lohani *et al.*, 2012). The barnyard millet has higher amounts of resistant starches due to high degree of retrogradation of amylase, which is a slowly digestible carbohydrate. Barnyard millet is most effective in reducing blood glucose and lipid levels. Hence, barnyard millet is nature’s gift for the patients with cardiovascular disease and diabetes mellitus and sedentary

activities of people. Nutritionally, millets are superior to cereals, but utilization of millet is not widespread. The major reason might be the lack of appropriate post harvest technologies for management of these crops (Chaturvedi *et al.*, 2018). One possible way of extending their utilization could be by blending them with different cereal flours after suitable processing. Hence, barnyard millet flour combined with wheat flour were taken to formulate chapathi to enhance the nutritional and functional properties.

MATERIALS AND METHODS

Raw Materials

Refined wheat flour and barnyard millet were purchased from local market, Madurai, Tamil Nadu, India.

Barnyard Flour Production

Millet was cleaned, winnowed and ground into flour.

Formulation of Composite Flour

Barnyard millet flour was substituted with wheat flour as 15%, 30%, 45% and 60% respectively. The flour was sieved through 40-mesh size. It can be stored for further analysis as rheological properties of dough and product development.

Rheological Properties of Dough using Farinogram

In the testing, finely grained barnyard millet (*Echinochloa* spp.), flour substituted as 15% to 60% to refined wheat flour and mixed together. These blends were evaluated on Farinograph-E, Brabender OHG, Duisburg, Germany (ICC Standard 115/1, 1992, AACC Method 54-21, 1995). Refined wheat flour was used as control. Sigma blades of farinograph worked with three different speeds: standard - 63 revs. Min-1, low - 45 revs. Min-1 and high - 120 revs. Min-1. The farinogram assesses the following properties such as changes of dough consistency (in FU Farinographic Unit), water absorption (%), development time (in min), stability (in min) and degree of softening (in FU). Tests were repeated three times and the results are presented by means of the three realize measurements.

Determination of Proximate Composition

The proximate composition of wheat flour and barnyard millet flour such as protein (g), fat (g), carbohydrate (g), total ash (%), crude fiber (g) and minerals such as iron (mg), calcium (mg) phosphorus (mg) and content of flour has been assessed following the standard AOAC methods (2005). The energy content of flours was computed by summing up the values obtained by multiplying the values with carbohydrates, crude fat and protein with 4, 9 and 4, respectively. Iron and calcium content of flour were analyzed by Atomic Absorption Spectrophotometer (AAS) (Model: AAS Analyst 700). Phosphorus content of flour was calculated by using food composition tables (Gopalan *et al.*, 2004).

Product Development

Wheat flour and barnyard millet flour in different ratios as 85:15 (variation I), 70:30 (variation II), 55:45 (variation III) and 60:40 (variation IV) for developed chapathi.

Sensory Analysis

The prepared chapathis were served to the panel members. The sensory analysis of the chapathi was assessed by trained and untrained judges using 9-point Hedonic scale. The panel members were asked to determine and estimate the chapathi

for different sensory attributes, viz., appearance, color, texture, flavor and overall acceptability. The separate pro forma was given to individual to record their observation.

Statistical Analysis

The experiments were carried out in triplicates and the results are expressed as mean $\pm$ standard deviations were reported. Analysis of variance (ANOVA) was performed and results were separated using the multiple ranges Duncan's test ($P < 0.05$) using INSTAT software.

RESULTS AND DISCUSSIONS

Table 1: Proximate Compositions of Wheat and Barnyard Millet Flour

Sl. No.	Nutrients per 100 g	Wheat Flour (%)	Barnyard Millet Flour (%)
1.	Moisture (%)	9.69 $\pm$ 0.1	8.66 $\pm$ 0.02
2.	Protein (g)	10.68 $\pm$ 0.05	10.52 $\pm$ 0.03
3.	Fat (g)	1.17 $\pm$ 0.02	3.56 $\pm$ 0.04
4.	Fiber(g)	0.51 $\pm$ 0.05	10.1 $\pm$ 0.06
5.	Energy (kcal)	348 $\pm$ 0.01	398 $\pm$ 0.01
6.	Carbohydrate (g)	76.4 $\pm$ 0.03	65.5 $\pm$ 0.03
7.	Minerals (g)	1.49 $\pm$ 0.1	4.4 $\pm$ 0.2
8.	Calcium (mg)	30 $\pm$ 0.05	11 $\pm$ 0.03
9.	Phosphorous (mg)	306 $\pm$ 0.02	280 $\pm$ 0.04
10.	Iron (mg)	3.5 $\pm$ 0.01	15.2 $\pm$ 0.08

Note: The values are expressed as mean of triplicates $\pm$ standard deviation (SD).

The proximate composition of wheat and barnyard millet flour is represented in table 1. The moisture content of wheat flour had 9.69% and barnyard millet flour had 8.66%. The moisture content of flour was below 12% to increase its shelf life content. Singh *et al.*, (2005) reported that the moisture content of flour had 10.01% to 12.17%. The protein content of wheat flour had 10.68 g/100 g and barnyard millet flour had 10.52 g/100 g. Further, fat content (3.6 g), fiber (10.1 g), mineral (4.4 mg) and iron content (15.2 mg) of barnyard millet flour was high as compared to wheat flour. From the result, it was observed that the mixture of barnyard millet flour to wheat flour for making composite flour increased the nutrient content. Premavalli *et al.*, (2005) reported that the use of millet flour to formulate the composite flour was expected to increase the concentration of protein, fat and fiber content.

Table 2: Rheological Properties of Barnyard Millet Flour to Wheat Flour Dough using Farinogram

Dough Characteristics	Refined Wheat Flour (RWF) (100%)	Barnyard Millet Flour (BMF)			
		15%	30%	45%	60%
Water absorption (14%)	54.2 $\pm$ 0.1	51.8 $\pm$ 0.1**	50.8 $\pm$ 0.2**	46.95 $\pm$ 0.2**	44.6 $\pm$ 0.4**
Development time (min)	5.2 $\pm$ 0	1.5 $\pm$ 0**	2.4 $\pm$ 1.2**	6.3 $\pm$ 0.1**	18.1 $\pm$ 2.6**
Stability Time (min)	6 $\pm$ 0.6	4.7 $\pm$ 0.3**	4.7 $\pm$ 0.28**	6.1 $\pm$ 0.2 ^{ns}	6.1 $\pm$ 1.2 ^{ns}
Tolerance index (FU)	42 $\pm$ 7	35.5 $\pm$ 0.7**	39 $\pm$ 12.1 ^{ns}	44.5 $\pm$ 0.7 ^{ns}	505 $\pm$ 49.4**
Time to breakdown (min)	8.3 $\pm$ 0.4	2.6 $\pm$ 0.2**	6.4 $\pm$ 0.3**	9.7 $\pm$ 0.2**	20 $\pm$ 0**
Farinograph Quality Number (mm)	83 $\pm$ 4.2	26 $\pm$ 2.8**	64.6 $\pm$ 3.2**	97.5 $\pm$ 2.1**	200 $\pm$ 0**

Values are means of triplicate determination $\pm$ SD. * denotes significant difference ($P \leq 0.05$)

Notes: FU = Farinograph unit, ** - 1% level, * - 5% level of significance; ns - not significant.

The purpose of the study was the formulation of composite flour suitable for chapathi making using maximum possible proportion of millets. 15%, 30%, 45% and 60% of barnyard millet flour mixed to wheat flour for the formulated composite flour. Assessed the rheological properties of composite flour such as water absorption (%), dough development

time (min), dough stability time (min), dough tolerance index (dough weakening) (BU), time to breakdown and farinograph quality number using farinogram. The result showed the replacement of barnyard millet flour mixed to wheat flour at different levels, such as 15% to 60% indicated that the water absorption of composite flour was decreased gradually from 51.8% to 44.6% then controlled (54.2%), which was significant to control ($P < 0.05$). The addition of millet flour in wheat flour may cause dilution of gluten, which will lead to deterioration of rheological property of the flour (Morad *et al.*, 1984). The dough development time of composite flour decreased to 15% for 1.5 min then increased to 30%, 45% and 60% for 2.4 min, 6.3 min and 18.1 min, respectively, which was significant to control ($P < 0.05$). A similar result was observed and the dough stability time of composite flour decreased to 15% and 30% for 4.7 min which was significant to control ($P < 0.05$), then increased to 45% and 60% for 6.1 min, which was not significant to control ($P > 0.05$). The increase in dough stability time, and increase in gluten content in composite flour (Shahzadi, 2004; Hosney, 1986). Time to break down dough was also decreased to 15% for 2.6 min and then increased to 30%, 45%, 60% for 6.4, 9.7 and 20 min, respectively, which was significant to control ($P < 0.05$). Weakening of dough (tolerance index) for 15% and 30% of barnyard millet flour substituted to wheat flour decreased as 35.5 FU and 39 FU then controlled (42 FU) but 45% and 60% of barnyard millet flour increased as 44 FU and 505 FU, respectively, then controlled, which was not significant to control ($P > 0.05$) except 15% mixture of barnyard millet flour. dough development time (min), stability time (min), tolerance index (FU), time of dough breakdown (min) and farinograph quality number were enhanced due to increase in the concentration of barnyard millet flour.

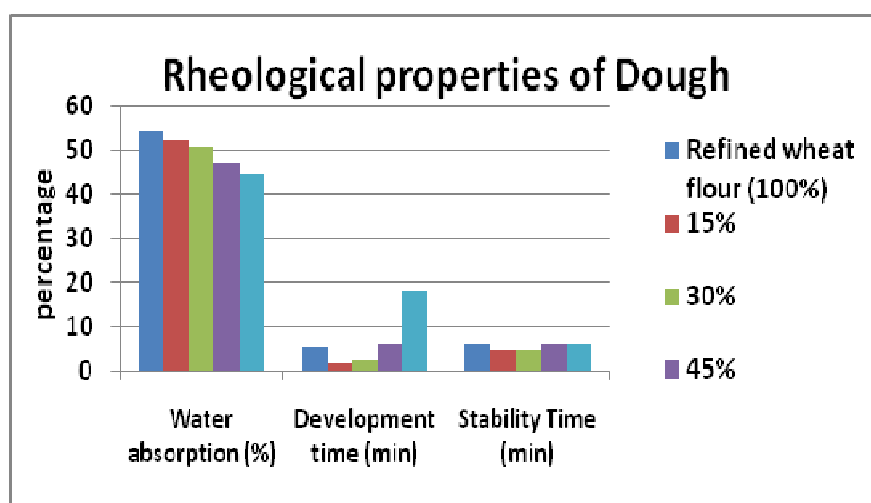
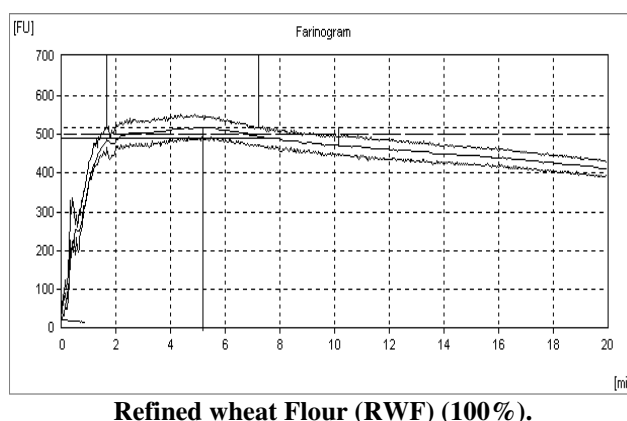


Figure 1: Rheological Properties of Dough.



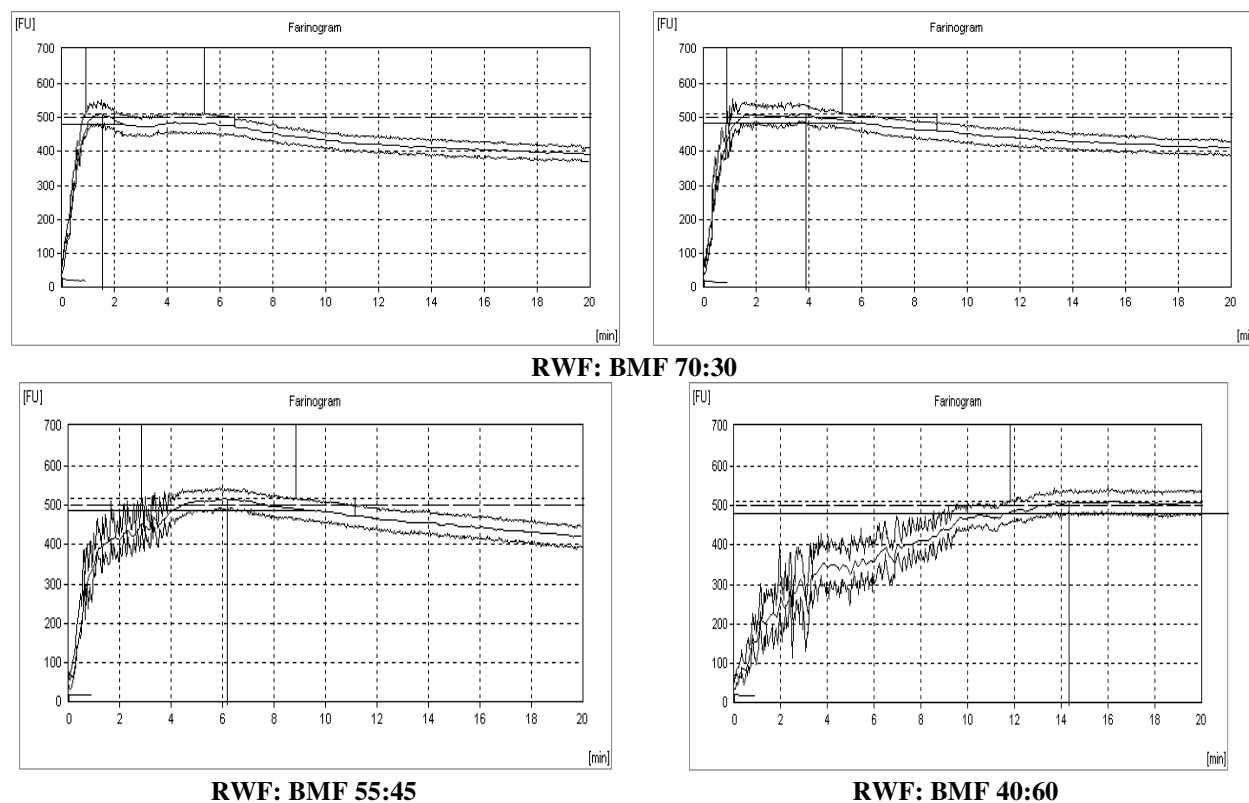


Figure 2: Rheological Properties of Composite Flour Analyzed using Farinogram.

Table 3: Sensory Evaluation of Chapathi Prepared from Barnyard Millet Substitution to Wheat Flour using 9-Point Hedonic Scale

Sensory Attributes of Chapathi	Refined Wheat Flour (100 %)	Barnyard Millet Flour			
		15%	30%	45%	60%
Appearance	8 ± 0.1	8.5 ± 0.03	8 ± 0.05	7 ± 0.1	6 ± 0.01
Color	8 ± 0.01	8.2 ± 0.05	7.8 ± 0.01	7 ± 0.5	6.5 ± 0.02
Taste	8 ± 0.02	8.3 ± 0.04	8 ± 0.03	6.8 ± 0.4	6.3 ± 0.4
Texture	8 ± 0.06	8.2 ± 0.05	7.5 ± 0.1	7 ± 0.3	6.4 ± 0.3
Flavor	8 ± 0.05	8 ± 0.09	8 ± 0.2	7.5 ± 0.1	6.2 ± 0.2
Over all acceptability	8 ± 0.03	8.2 ± 0.1	7.8 ± 0.3	7 ± 0.02	6.01 ± 0.1

Values are means of triplicate determination $\pm$ SD.

From the results, it was indicated that incorporation of barnyard millet flour at different levels (15%, 30%, 45% and 60%) to wheat flour for the formulated chapathi using 9-point hedonic scales are depicted in table 3. Overall, sensory scores of chapathi indicated that 15% and 30% of barnyard millet flour had 8.2 and 7.8, respectively, which was highly acceptable as compared to 45% and 60% of barnyard millet flour (7.8 and 6.01). Similar data was stated that the bread incorporated with 20% minor millet was highly acceptable by panel when compared to other treatments (AA Nour *et al.*, 2015). Mixture of barnyard millet flour above 30% substituted with wheat flour for making chapathi look hard, i.e., without a smooth appearance due to the development of a strong protein network and a high-fiber and protein content, which creates the non-uniformities at the chapathi preparation time. Further flavor also reduced to 30% of barnyard millet flour mixture of chapathi due to the aromatic flavor of the barnyard millet flour, which is the prominent reason. It can be rectified by the addition of vegetable oil and salt for the formulated chapathi, which helps to defeat the sensory defects. The results indicated that up to 30% of barnyard millet flour was substituted for wheat flour for making chapathi highly acceptable.

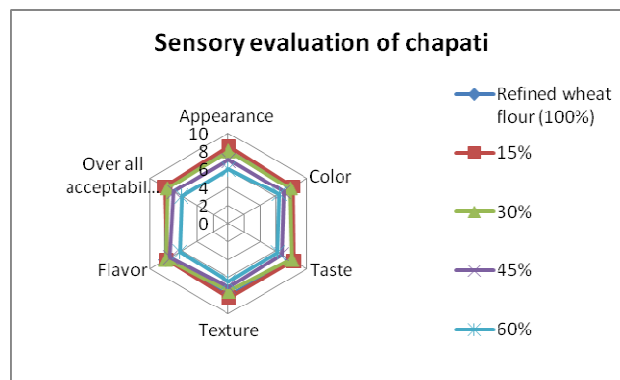


Figure 3: Sensory Evaluation of Chapathi using 9-point Hedonic Scale.

CONCLUSIONS

As the result concludes that 15% and 30% mixture of barnyard millet substituted with wheat flour had the good rheological properties and overall acceptability of chapathi, so barnyard millet could be successfully value added which increased the nutrient content without ignoring the palatability, and various innovative products may be developed to suit the consumer needs and also achieve nutrition.

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